

**FEED MATERIALS PRODUCTION CENTER
ENVIRONMENTAL MONITORING ANNUAL
REPORT FOR 1972**

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FEED MATERIALS PRODUCTION CENTER
ENVIRONMENTAL MONITORING ANNUAL REPORT
FOR 1972

Prepared by
HEALTH AND SAFETY DIVISION

NATIONAL LEAD COMPANY OF OHIO
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UNITED STATES ATOMIC ENERGY COMMISSION
CINCINNATI AREA

FMPC ENVIRONMENTAL MONITORING REPORT

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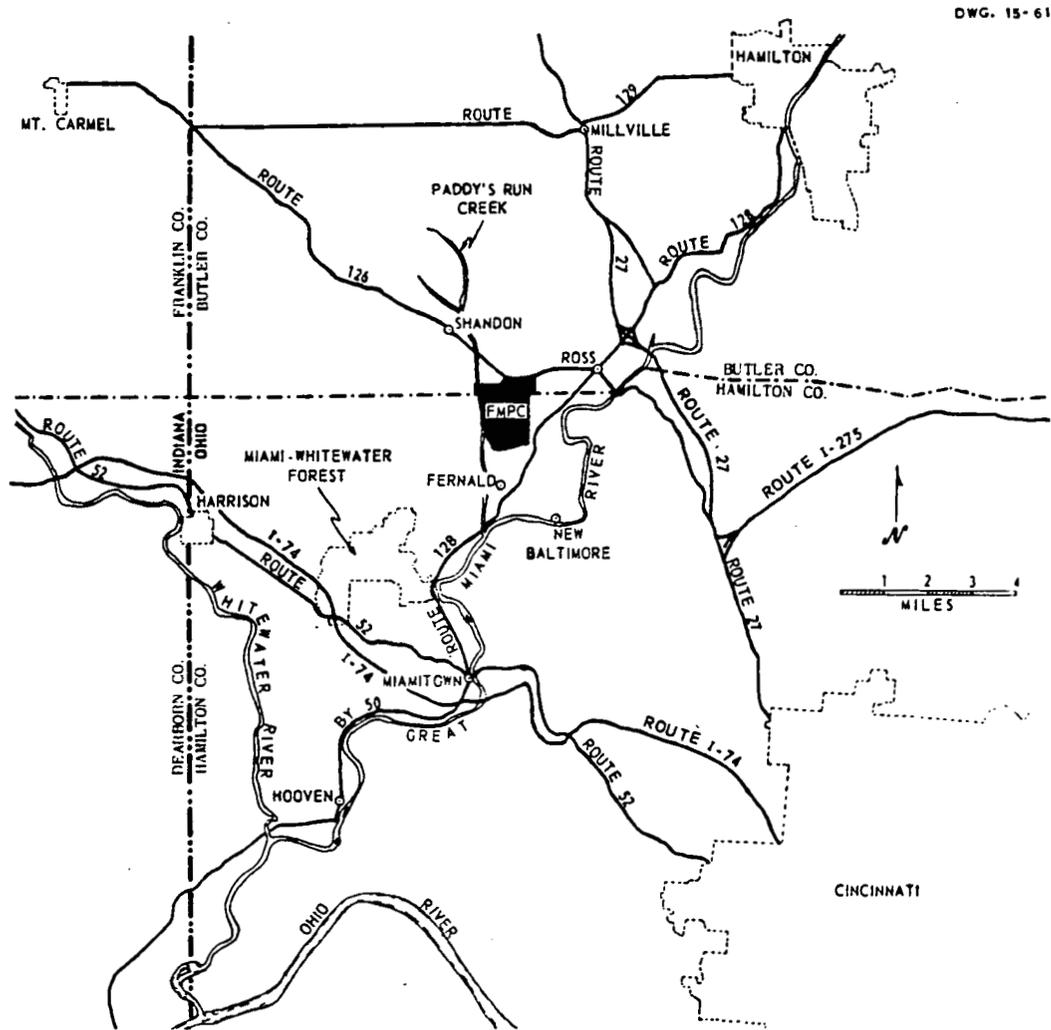
INTRODUCTION

This report summarizes environmental monitoring data collected at the Feed Materials Production Center (FMPC) during 1972. Data are presented for both radioactive and non-radioactive contaminants in environmental samples. These data show that the average offsite concentrations of radioactive contaminants from FMPC operations were less than 0.5% of the guide levels published in AEC Manual Chapter 0524. The resulting offsite radiation exposures would, therefore, be a small fraction of the standards for uncontrolled areas.

The FMPC is an industrial facility owned by the Atomic Energy Commission and operated by the National Lead Company of Ohio. It is located on a 1050-acre site about 20 miles northwest of Cincinnati, Ohio. Several rural communities are 1-3 miles away. See Figure 1 for a map of the area.

The primary work at the FMPC is the production of purified uranium metal and compounds for use at other AEC sites. A small amount of thorium is also processed.

Uranium production may begin with ore concentrates, recycled uranium from spent reactor fuel, or with various compounds from other AEC sites. Impure starting material is dissolved in nitric acid and the uranium is extracted into an organic liquid and then back-extracted into dilute nitric acid to yield a solution of uranyl nitrate.



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FIGURE 1 Area Map of Relative Locations

Evaporation and heating convert the nitrate solution to uranium trioxide (UO₃) powder. This compound is reduced to uranium dioxide (UO₂) with hydrogen and then converted to uranium tetrafluoride (UF₄) by reaction with anhydrous hydrogen fluoride. Uranium metal is produced by reacting UF₄ and magnesium metal in a refractory-lined reduction vessel. This primary uranium metal is then remelted with scrap uranium metal to yield a purified uranium ingot which is rolled or extruded to form rods or tubes. Sections are then cut and machined to final dimensions. These machined cores are then shipped to other AEC sites for canning and final assembly into reactor fuel elements.

Thorium production steps, in general, are similar to those followed in uranium production. Final products may be purified thorium nitrate solution, solid thorium compounds, or metal.

STANDARDS

There are several sets of standards which can be applied to environmental samples collected in connection with FMPC operations. These standards have been set by the AEC and the State of Ohio Environmental Protection Agency (EPA).

AIR. The AEC specifies limits for radionuclides in air and water which must be followed by contract operators such as

the National Lead Company of Ohio.⁽¹⁾ These criteria, published in AEC Manual Chapter 0524, specify maximum concentrations in work areas and in offsite areas which are beyond AEC control.

For environmental monitoring purposes, the criteria for air and water in uncontrolled areas are used as standards. At the FMPC, criteria for offsite or ambient air are applied to samples collected at the plant boundary.

Criteria used for non-radioactive contaminants in ambient air are those established by the Ohio EPA.⁽²⁾ Current production operations exhaust particulates and oxides of nitrogen in sufficient quantity to warrant boundary sampling for these contaminants.

WATER. As previously noted, standards for radionuclides in water have been specified by the AEC for use by the Commission's contract operators. Criteria for offsite water are applied to river samples collected downstream from the point where the plant effluent reaches the river, but upstream from any known use of the water as a drinking water supply.

Water quality criteria adopted by the State of Ohio are mainly concerned with non-radioactive contaminants, but several radioactivity limits are included.⁽³⁾ The criteria are applied to samples collected downstream from the FMPC effluent discharge point.

In addition to water quality standards originally adopted by the Ohio Water Pollution Control Board and now enforced by the State EPA, the National Lead Company of Ohio uses other criteria recommended by the State Department of Health. These criteria are for chloride,⁽⁴⁾ nitrate,⁽⁴⁾ and non-filterable solids.⁽⁵⁾ The criteria for chloride and nitrate are similar to those recommended by the Public Health Service for potable water supplies⁽⁶⁾ and are applied to the river downstream from the plant effluent line. The limit for non-filterable solids was set by agreement with the State and it is applied to the effluent before mixing in the river.

SAMPLE COLLECTION AND ANALYSES

AIR. Conversion of impure uranium and thorium compounds to reactor-grade feed materials involves operations which generate radioactive dust, nuisance dusts, and corrosive mists or reaction products. Ventilation and air cleaning systems are used to confine this air and remove airborne contaminants, including valuable material which is returned to the production processes. The filtered or scrubbed air is exhausted to the atmosphere. Sampling of these stack exhausts is maintained on a continuous schedule to determine the operating condition of the air cleaning systems.

During 1972, samples of particulate matter in air were continuously collected at six permanent sampling stations located on the project's outer boundary (see Figure 2). At each Boundary Station, a metered quantity of air is drawn through a filter which is changed weekly. Filters are weighed before use and then reweighed after changing to obtain the weight of collected dust. After reweighing, the filter and its collection of dust is dissolved in acid and the solutions are analyzed for uranium and alpha and beta radioactivity. After these analyses are completed the remaining solution is held to provide a long-term composite for thorium analyses. Frequent thorium analyses are not considered necessary because of the small amount of thorium processed and the low concentration of thorium found in the boundary samples.

Several times during the year 24-hour sampling for oxides of nitrogen was carried out at selected Boundary Stations. In each case the location selected was downwind from the project's major source of NO₂ emissions.

WATER. Each of the individual production plants on the project has sumps and equipment for the collection and initial treatment of process waste water. Uranium and thorium may be recovered as part of the treatment. Effluents from the plants are collected at a central facility, called the General Sump, for additional

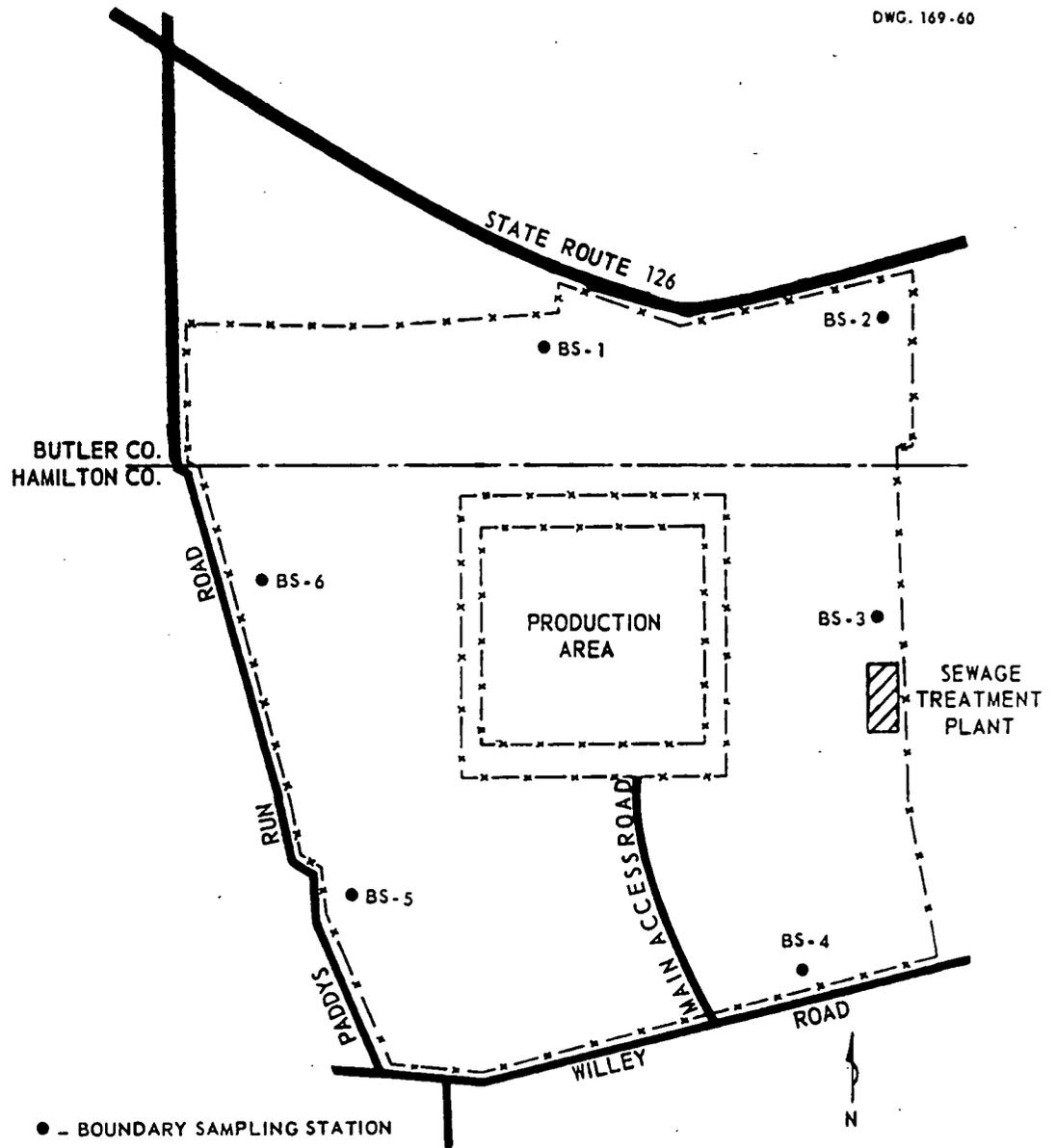


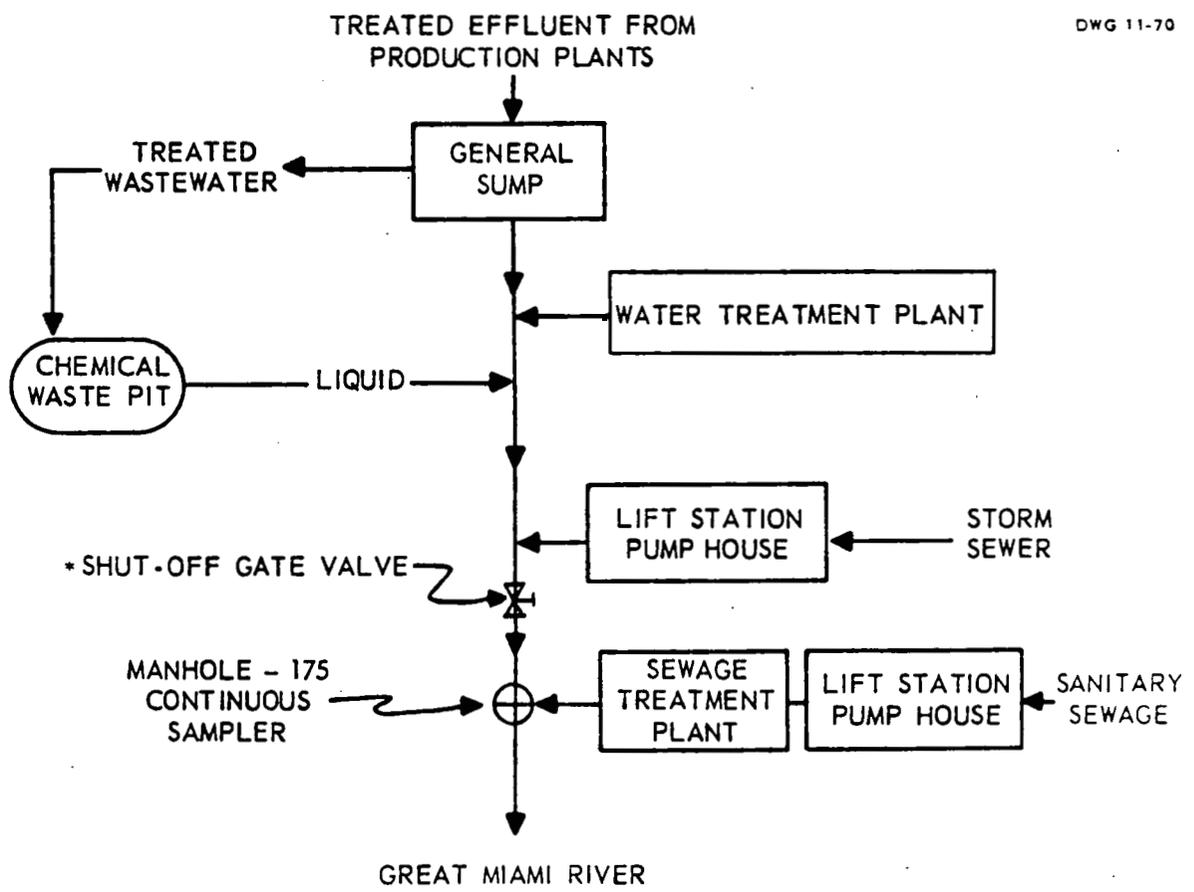
FIGURE 2 Soil and Air Sampling Locations

treatment. The treated wastes are then discharged into a large pit where the solids settle to the bottom. Clear effluent from the pit is combined with the other water streams and discharged to the Great Miami River. See Figure 3 for a diagram of the process.

Water samples are collected at several points to determine the effect of the effluent upon the river. Locations are shown in Figure 4. At point W1, upstream from the effluent discharge, a daily grab sample is collected. At the final access point on the waste line, a Parshal Flume type water sampler collects continuously a sample which is proportional to the total flow. This sample is collected and analyzed on a daily basis. Results of these analyses, combined with river flow measurements, are used to calculate contaminant concentrations added to the river at point W2. At point W3, downstream on the river from the discharge point, 24-hour samples are collected by a continuous sampler.

Daily samples from the final access point (W2) are analyzed for uranium, alpha and beta radioactivity, chloride, fluoride, nitrate, non-filterable solids, and pH. The same analyses are made on at least one sample per week from each of the river sampling points (W1 and W3). Results of this monitoring have been reported to the State of Ohio on a monthly basis since 1954.

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• Storm sewer water can be diverted to the Chemical Waste Pit or the General Sump by first halting the pumping from both locations and then closing the shut-off gate valve in the process waste line.

FIGURE 3 Flow Diagram of Chemical Waste and Disposal Process

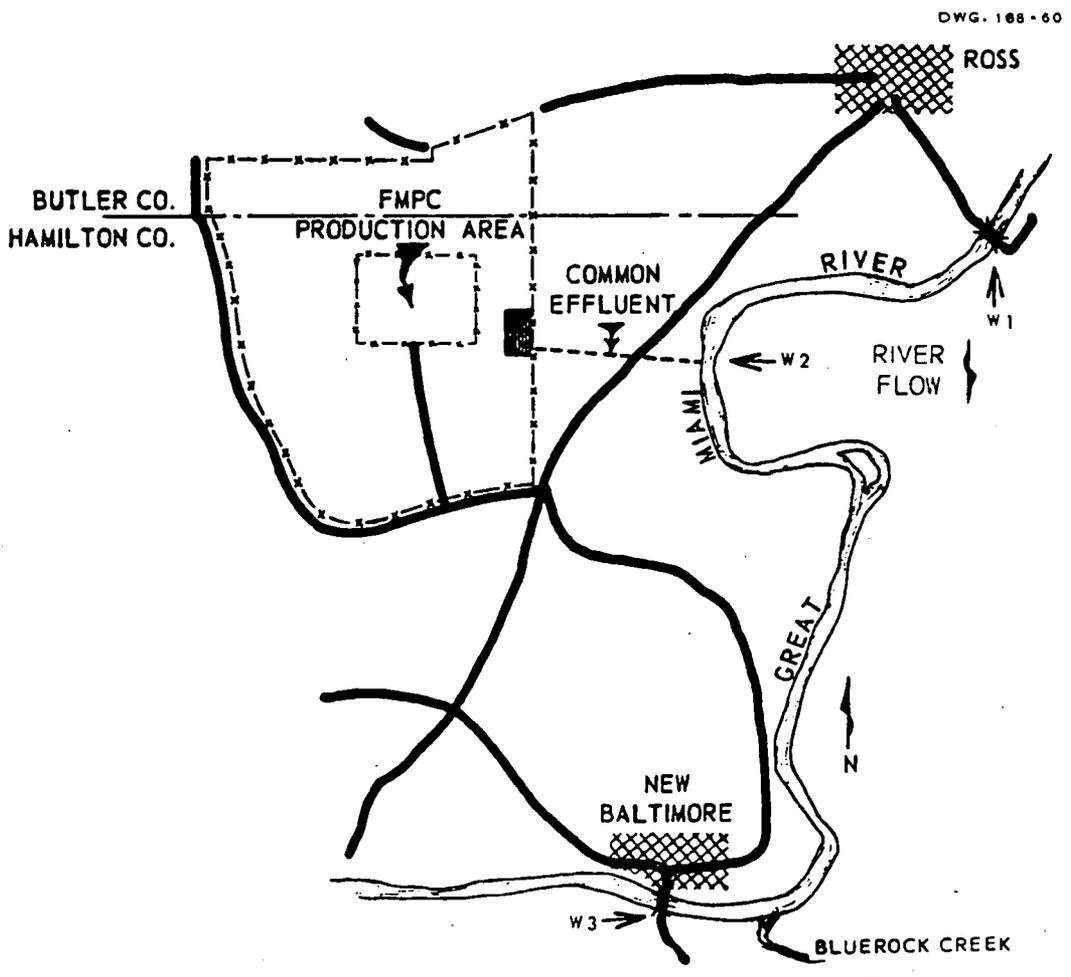


FIGURE 4 Water Sampling Locations

Each month, single upstream and downstream river samples collected at points W1 and W3 are analyzed for radium²²⁶ and radium²²⁸. Two-week composites from the waste-line final access point (W2) are analyzed for radium and one-month composites are analyzed for thorium.

SOIL. At least once each year, soil samples are collected near the six Boundary Sampling Stations. Each sample consists of six cores, 2 cm diameter and 10 cm deep. The cores are taken about 1.5 meters apart. These samples are analyzed for uranium to observe the possible contribution from stack effluents.

MONITORING DATA

Environmental data collected during 1972 are given in Tables 1-5. Where appropriate, comparisons are made with the applicable standard for each contaminant.

Data in Table 1 show that the average radionuclide concentrations in air, at the boundary sampling stations, were no greater than 0.4% of their respective standards for offsite areas. It is concluded from these data that any offsite radiation exposure resulting from FMPC airborne contaminants would be a small fraction of the standards given in reference (1).

TABLE 1 Radioactive Contaminants in Air

Contaminant	Sampling Point (1)	Number of Samples	Maximum Conc Found		Minimum Conc. Found		Average Concentration Found				Detection Level	Standard (2)
			μCi/ml	μg/m ³	μCi/ml	μg/m ³	μCi/ml	μg/m ³	% of Standard	95% Confidence Limit		
Uranium	BS-1	41	1.42 × 10 ⁻¹⁴	0.043	0.04 × 10 ⁻¹⁴	0.001	0.60 × 10 ⁻¹⁴	0.018	0.3			
	BS-2	44	5.44 × 10 ⁻¹⁴	0.162	0.04 × 10 ⁻¹⁴	0.001	0.60 × 10 ⁻¹⁴	0.018	0.3			
	BS-3	40	1.45 × 10 ⁻¹⁴	0.044	0.09 × 10 ⁻¹⁴	0.003	0.91 × 10 ⁻¹⁴	0.027	0.4			
	BS-4	46	1.49 × 10 ⁻¹⁴	0.045	0.06 × 10 ⁻¹⁴	0.002	0.28 × 10 ⁻¹⁴	0.008	0.1			
	BS-5	42	0.77 × 10 ⁻¹⁴	0.023	0.07 × 10 ⁻¹⁴	0.002	0.35 × 10 ⁻¹⁴	0.011	0.2			0.01 × 10 ⁻¹² μCi/ml
	BS-6	43	1.90 × 10 ⁻¹⁴	0.057	0.12 × 10 ⁻¹⁴	0.004	0.68 × 10 ⁻¹⁴	0.022	0.3			
Thorium	BS-1	1(3)	NA(4)	NA	NA	NA	0.03 × 10 ⁻¹⁵	0.0003	<0.001			
	BS-2	1	NA	NA	NA	NA	0.02 × 10 ⁻¹⁵	0.0002	<0.001			
	BS-3	1	NA	NA	NA	NA	0.03 × 10 ⁻¹⁵	0.0003	<0.001			1.1 × 10 ⁻¹⁷ μCi/ml
	BS-4	1	NA	NA	NA	NA	0.02 × 10 ⁻¹⁵	0.0002	<0.001			
	BS-5	1	NA	NA	NA	NA	0.01 × 10 ⁻¹⁵	0.0001	<0.001			
	BS-6	1	NA	NA	NA	NA	0.01 × 10 ⁻¹⁵	0.0001	<0.001			
Gross Alpha Radioactivity	BS-1	41	1.42 × 10 ⁻¹³	NA	0.05 × 10 ⁻¹⁴	NA	0.54 × 10 ⁻¹⁴	NA	0.3			
	BS-2	44	4.17 × 10 ⁻¹⁴	NA	0.06 × 10 ⁻¹⁴	NA	0.56 × 10 ⁻¹⁴	NA	0.3			
	BS-3	40	1.38 × 10 ⁻¹⁴	NA	0.20 × 10 ⁻¹⁴	NA	0.77 × 10 ⁻¹⁴	NA	0.4			
	BS-4	46	1.66 × 10 ⁻¹⁴	NA	0.09 × 10 ⁻¹⁴	NA	0.32 × 10 ⁻¹⁴	NA	0.2			
	BS-5	42	0.62 × 10 ⁻¹⁴	NA	0.12 × 10 ⁻¹⁴	NA	0.39 × 10 ⁻¹⁴	NA	0.2			0.01 × 10 ⁻¹² μCi/ml
	BS-6	43	2.07 × 10 ⁻¹⁴	NA	0.19 × 10 ⁻¹⁴	NA	0.64 × 10 ⁻¹⁴	NA	0.3			
Gross Beta Radioactivity	BS-1	41	9.58 × 10 ⁻¹⁴	NA	0.57 × 10 ⁻¹⁴	NA	5.40 × 10 ⁻¹⁴	NA	0.005			
	BS-2	44	23.21 × 10 ⁻¹⁴	NA	1.20 × 10 ⁻¹⁴	NA	5.66 × 10 ⁻¹⁴	NA	0.006			
	BS-3	40	10.05 × 10 ⁻¹⁴	NA	1.81 × 10 ⁻¹⁴	NA	6.01 × 10 ⁻¹⁴	NA	0.006			
	BS-4	46	8.48 × 10 ⁻¹⁴	NA	1.16 × 10 ⁻¹⁴	NA	4.76 × 10 ⁻¹⁴	NA	0.005			
	BS-5	42	9.01 × 10 ⁻¹⁴	NA	1.28 × 10 ⁻¹⁴	NA	5.36 × 10 ⁻¹⁴	NA	0.005			
	BS-6	43	38.36 × 10 ⁻¹⁴	NA	2.68 × 10 ⁻¹⁴	NA	7.44 × 10 ⁻¹⁴	NA	0.007			0.01 × 10 ⁻¹² μCi/ml

Footnotes:

- (1) See sampling locations shown in Figure 2.
- (2) See reference 1.
- (3) Composite samples, consisting of 13 continuous samples which cover the period 1/16/72 - 3/30/72.
- (4) Not applicable.

The concentrations of particulate matter and NO₂ found at the boundary are given in Table 2. At three sampling locations the average concentration of particulate matter exceeded the annual arithmetic mean set by the Ohio EPA. These locations are on the upwind side of the project in respect to the direction of prevailing winds. Therefore, they should be less affected by project operations than the other three sampling locations. There may have been some contribution from traffic on adjacent highways or farming activities in near-by fields.

Concentrations of NO₂ reported in Table 2 were obtained on days when levels of operation, combined with weather conditions, were expected to produce maximum concentrations at the boundary. The average concentration of all samples was 14.6% of the ambient standard annual arithmetic mean set by the State of Ohio. As shown, the highest concentration was 30.8% of the standard.

Table 3 contains information on radionuclides in water. As shown, the average concentrations of uranium, thorium, and radium added to the river was <0.001% of the AEC Radiation Protection Standards. The average upstream concentrations of radium²²⁶ and radium²²⁸ were 2.8% and 1.4% of the standard for uncontrolled areas.

State criteria for gross beta and dissolved alpha radioactivity were not exceeded in the river. The calculated addition of

TABLE 2 Particulate Matter and NO₂ in Air

Contaminant	Sampling Point (1)	Number of Samples	Conc. Found		Average Conc. Found			Detection Level	Standard (2)
			Maximum $\mu\text{g}/\text{m}^3$	Minimum $\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$	% of Standard	95% Confidence Limit		
Particulates	BS 1	41	105	32	58	90.7	$\pm 5\%$	$1 \mu\text{g}/\text{m}^3$	$60 \mu\text{g}/\text{m}^3$
	BS 2	45	122	31	56	93.3			
	BS 3	40	83	10	50	83.3			
	BS 4	45	123	36	65	108.3			
	BS 5	43	121	36	62	103.3			
	BS 6	43	212	38	64	106.7			
NO ₂	BS-1	1	-	-	13.0	13.1	$\pm 30\%$	$1 \mu\text{g}/\text{m}^3$	$100 \mu\text{g}/\text{m}^3$
	BS 2	6	30.8	<1	16.0	16.0			
	BS 5	3	12.4	7.1	9.1	9.1			

Footnotes.

(1) See sampling locations shown in Figure 2.

(2) See reference 2.

TABLE 3 Radioactive Contaminants in Water

Contaminant	Sampling Point (1)	Number of Samples	Maximum Conc. Found		Minimum Conc. Found		Average Concentration Found					Detection Level $\mu\text{Ci/ml}$	Standard
			$\mu\text{Ci/ml}$	mg/l	$\mu\text{Ci/ml}$	mg/l	$\mu\text{Ci/ml}$	mg/l	% of Standard	95% Confidence Limit $\mu\text{Ci/ml}$			
Uranium (2)	W1	53	0.67×10^{-7}	0.200	$< 0.01 \times 10^{-7}$	0.001	0.04×10^{-7}	0.012	0.02	$\pm 0.5 \times 10^{-8}$	1.0×10^{-10}	2×10^{-5}	
	W2	366	0.50×10^{-9}	0.001	0.08×10^{-9}	< 0.001	0.17×10^{-9}	< 0.001	< 0.001	NA(4)	NA	$\mu\text{Ci/ml}$	
	W3	53	0.17×10^{-7}	0.050	$< 0.01 \times 10^{-7}$	0.001	0.01×10^{-7}	0.004	0.005	$\pm 0.5 \times 10^{-8}$	1.0×10^{-10}	(5)	
Thorium(2)	W2	6(3)	4.90×10^{-13}	4.30×10^{-8}	3.24×10^{-13}	2.84×10^{-8}	4.17×10^{-13}	3.66×10^{-8}	< 0.001	NA	NA	1×10^{-8}	
Radium 226	W1	12	18.16×10^{-10}	NA	$< 4.54 \times 10^{-10}$	NA	9.08×10^{-10}	NA	2.8	$\pm 4.5 \times 10^{-10}$	4.5×10^{-10}	3×10^{-8}	
	W2	24	0.74×10^{-10}	NA	0.02×10^{-10}	NA	0.22×10^{-10}	NA	< 0.001	NA	NA	$\mu\text{Ci/ml}$	
	W3	12	9.08×10^{-10}	NA	$< 4.54 \times 10^{-10}$	NA	4.54×10^{-10}	NA	1.4	$\pm 4.5 \times 10^{-10}$	4.5×10^{-10}	(5)	
Radium 228	W1	12	9.08×10^{-10}	NA	$< 4.54 \times 10^{-10}$	NA	4.54×10^{-10}	NA	1.4	$\pm 4.5 \times 10^{-10}$	4.5×10^{-10}	3×10^{-8}	
	W2	24	0.23×10^{-10}	NA	0.01×10^{-10}	NA	0.06×10^{-10}	NA	< 0.001	NA	NA	$\mu\text{Ci/ml}$	
	W3	12	18.16×10^{-10}	NA	$< 4.54 \times 10^{-10}$	NA	9.08×10^{-10}	NA	2.8	$\pm 4.5 \times 10^{-10}$	4.5×10^{-10}	(5)	
Dissolved Alpha	W2	72	9.70×10^{-10}	NA	0.94×10^{-10}	NA	2.93×10^{-10}	NA	9.8	NA	NA	3×10^{-9}	
Gross Beta	W1	53	4.54×10^{-7}	NA	0.04×10^{-7}	NA	0.26×10^{-7}	NA	2.6	$\pm 0.9 \times 10^{-8}$	6×10^{-9}	1×10^{-6}	
	W2	366	0.04×10^{-7}	NA	$< 0.01 \times 10^{-7}$	NA	0.01×10^{-7}	NA	0.1	NA	NA	$\mu\text{Ci/ml}$	
	W3	53	0.86×10^{-7}	NA	0.04×10^{-7}	NA	0.15×10^{-7}	NA	1.5	$\pm 0.9 \times 10^{-8}$	6×10^{-9}	(6)	

Footnotes

- (1) See sampling locations shown in Figure 4. W1 - Miami River, upstream at Ross, Ohio; W2 - Calculated addition to the river based on effluent analyses and river flow W3 - Miami River downstream at New Baltimore, Ohio
- (2) In accordance with Manual Chapter 0524 a curie of natural uranium means a total of 7.49×10^{10} dis./sec. and a curie of natural thorium means a total of 7.4×10^{10} dis./sec.
- (3) Each sample is a one month composite of daily 24 hour samples. Analyses were made for the first six months of 1972
- (4) Not applicable.
- (5) See reference 1
- (6) See reference 3

gross dissolved alpha did average 9.8% of the State criteria. However, this alpha activity was due principally to uranium, for which the AEC standard is substantially higher. The more limiting State standard is intended to provide control over all alpha emitters, including radium²²⁶ which must be kept at a concentration much lower than other less important radionuclides.

Operations at the FMPC did not cause any State standard for non-radioactive contaminants to be exceeded in the river. The contaminants listed in Table 4 were selected for analysis and reporting because of the possibility of adding to the river contaminant concentrations which were >1% of the applicable State standards.

There are no standards for comparison with the results for uranium in soil listed in Table 5. Although the normal value for uranium in local soil is 1-4 µg/g, there are no hazards associated with the elevated soil uranium produced by FMPC operations. External radiation from uranium is slight and the exposure contribution from these onsite concentrations would be considerably less than 1% of the Radiation Protection Standard for people in uncontrolled areas.

TABLE 4 Non-Radioactive Contaminants in Water

Contaminant	Sampling Point (1)	Number of Samples	Maximum Conc. Found mg/l	Minimum Conc. Found mg/l	Average Concentration Found			Detection Limit	Standard
					mg/l	% of Standard	95% Confidence Limit		
Chloride	W1	53	73	13	41	16.4	± 10%	1 mg/l	250 mg/l ⁽²⁾
	W2	366	0.2	0.02	0.06	0.02			
	W3	53	76	14	41	16.4			
Filterable Solids	W1	53	482	11	89	NA ⁽³⁾	± 20%	4 mg/l	100 mg/l ⁽⁴⁾
	W2	366	119	19	48	48			
	W3	53	638	7	89	NA			
Fluoride	W1	53	0.96	0.28	0.52	52	± 15%	0.2 mg/l	1 mg/l ⁽⁵⁾
	W2	366	0.009	< 0.001	0.002	0.2			
	W3	53	1.77	0.10	0.48	48			
Nitrate	W1	53	36.3	7.1	22.8	51.8	± 10%	0.3 mg/l	44 mg/l ⁽²⁾
	W2	366	5.9	0.3	1.8	4.1			
	W3	53	41.9	15.4	25.6	58.2			

Footnotes:

- (1) See Figure 4.
- (2) See reference 3.
- (3) Not applicable.
- (4) Agreement with the Ohio Department of Health for average concentration in the plant effluent.
- (5) See reference 3.

TABLE 5 Uranium in Soil - Onsite Locations

Sampling Point (1)	Uranium Concentration (2)			Detection Level
	µCi/g	µg/g	95% Confidence Limit	
BS-1	0.9 × 10 ⁻⁶	2.6	± 25%	0.5 µg/g
BS-2	3.9 × 10 ⁻⁶	11.8		
BS-3	14.8 × 10 ⁻⁶	44.3		
BS-4	1.5 × 10 ⁻⁶	4.4		
BS-5	2.3 × 10 ⁻⁶	6.8		
BS-6	2.5 × 10 ⁻⁶	7.4		

Footnotes:

- (1) See sampling locations shown in Figure 2.
- (2) Results on dry basis.

REFERENCES

- (1) U. S. Atomic Energy Commission, AEC Manual Chapter 0524, Standards for Radiation Protection. February 4, 1969.
- (2) State of Ohio Department of Health, Water Pollution Control Board. Regulations adopted January 28, 1972; effective February 15, 1972.
- (3) State of Ohio Department of Health, Water Pollution Control Board. "Resolution Establishing Amended Criteria of Stream-Water Quality for Various Uses Adopted by the Board on April 14, 1970."
- (4) State of Ohio Department of Health. "Report of Water Pollution Study of Miami River." 1951.
- (5) Agreement between the Ohio Department of Health and the National Lead Company of Ohio.
- (6) U. S. Public Health Service. 1962. Public Health Service Drinking Water Standards, 1962. PHS Pub. No. 956, Washington, D. C.